notice on my part because it impugns not only the verbal statements made to many astronomers who have inspected the instruments of the U.S. Naval Observatory, but also the correctness of an official report made by me to the Superintendent of the Naval Observatory, and appended by him to his report for the year 1893, printed copies of which have been distributed to nearly all the observatories in the world.

The paragraph in question is based upon an illustrated article in the *Zeitschrift für Instrumentenkunde*, 1894, 14 Jahrgang. pp. 128–130, which purports to be a description of the 12-inch equatorial telescope of the Georgetown College Observatory, and in which it is asserted (1) that the instrument was constructed *nearly three years ago* by Mr. Geo. N. Saegmuller, of Washington, D.C.; (2) that its principal novelty is a pair of star dials, or finding circles; and (3) that similar instruments have been constructed by Mr. Saegmuller for the U.S. Naval Observatory at Washington, and for other institutions which are named. From these statements the writer of the "Astronomical Column" very naturally inferred that Mr. Saegmuller constructed these dials, or finding circles, three years ago, when in reality he did nothing of the kind. The facts are as follows:—The idea of these finding circles first occurred to me while the question of building a 12-inch equatorial mounting for the U.S. Naval Observatory was under consideration, and in the specifications for that instrument, which were dated May 20, 1891, I embodied it in these words: "Connected with them (the quick motions) and arranged so as always to face a person operating them, suitable indicators shall be provided for showing automatically the right ascension and declination of the point to which the telescope is directed." Mr. Saegmuller got the contract for building that mounting, and the details of these indicators were arranged between us. The erection of the mounting at the Naval Observatory was completed in November 1892, and almost immediately thereafter Mr. Saegmuller put an exact copy of its indicators upon the Georgetown College telescope, *which he had erected some time previously*. Finally, the two woodcuts which illustrate the *Zeitschrift's* article are not pictures of the Georgetown College telescope, but of the Naval Observatory telescope, which differs from the Georgetown instrument in many details. Wm. Harkness.

Washington, D.C., June 7.

On the Use of Quartz Fibres in Telescopes.

Perhaps it may interest some of your readers to know that the quartz fibres of Prof. Boys affords an excellent material for providing the eye-lens of telescopes, and specially the instruments used in combination with reflecting galvanometers and electrometers, with threads required for their adjustment on the divisions of the scale. I thought at first that as the fibres appear, when examined with the microscope, to be semi-transparent and have a silver-grey colour, they would, when seen behind the ocular lens, not present themselves as distinct and clear lines, but as a matter of fact, when they were put at the proper distance, they showed an intense *black* colour, even darker than the divisions made with ink on the scale on which the instruments were focussed. I used threads of 20 microns diameters, and they can be fixed on the diaphragm without much difficulty by means of a mixture of resin and mastic applied with a heated wire, and this mixture answers better than brittle shellac. It is obvious that the threads, when laid down in the diaphragm, are at once stretched, and remain in good condition, as they are not affected in any appreciable degree by the influence of heat and atmospheric moisture. L. Bleekrode.

The Hague, June 18.

Bullet-Proof Shields.

In reply to a letter on bullet-proof shields, in the last number of Nature, I wish to state that some preliminary experiments with spheres show that the energy of the shot is transmitted to the spheres nearly in line with the direction of the blow, to such a degree that great damage is done to the board to which the spheres are attached. This is not the case when rods are used. I hope shortly to give the details of my experiments on the subject. Frederick J. Smith.

Oxford, June 16.

THE HORN EXPEDITION FOR THE SCIENTIFIC EXPLORATION OF CENTRAL AUSTRALIA.

Information has been received of the organization and despatch from Adelaide of a new and well-equipped expedition for the scientific exploration of the Macdonnell Ranges which lie about eleven hundred miles to the northward of that capital and nearly in the centre of the Australian continent. The expense of this expedition is borne by a wealthy and public-spirited colonist of South Australia, Mr. William Austin Horn, who thirty years ago carried out on his own account some explorations in the Gawler Ranges, and has since taken a very active part in the development of the mineral resources of the country, besides being a prominent member of the colonial legislature and of the Council of the University of Adelaide. Mr. Horn himself is the leader of the present Expedition, but has wisely associated with him some scientific gentlemen of great experience in Australian travel. Among them are Mr. Charles Winnecke, of the Trigonometrical Survey of South Australia, who in the performance of his duties has repeatedly traversed some of the most arid country of the continent, and has mapped out some thirty thousand square miles of its surface. With him also goes as medical officer, Dr. E. C. Stirling, C.M.G., F.R.S., of the University of Adelaide, the well-known discoverer, a few years since, of *Notoryctes*, and latterly the investigator of the *Diprotodon*-deposits, the results of which so many are impatiently expecting, though now it is clear that for them they will have to await his return from this new undertaking, the charms of which he found it impossible to resist. Besides these there are of the party, Prof. Ralph Tate, also of the University of Adelaide, and President of the last meeting of the Australasian Association for the Advancement of Science, eminent as a palæontologist, and especially as a palæobotanist, as well as Prof. Baldwin Spencer, whose name, from his connection with Owens College and Oxford, will be at once recognised by all; while there is also Mr. J. Alexander Watt, of the Geological Survey of New South Wales, to pay special attention to mineralogy and petrology. In the capacity of collecting naturalists, Mr. F. W. Belt, of Adelaide, and Mr. G. A. Keartland, of Melbourne, complete the staff of the expedition, which will be accompanied by three camel-drivers, a cook, and two prospectors sent by the Government. The Expedition was to leave Adelaide on May 3rd for Oodnadatta, and thence proceed along the telegraph line as far as Lilia Creek, where it will turn to the westward towards the Ayers Range and Goyder's Springs, after which it will make for the Palmer River, and then, deviating again to the westward towards Petermann Creek, will return to the upper valley of the Finke River, and then push on to Glen Helen at the foot of the Macdonnell Ranges. It will of course be understood that circumstances may cause this plan to be modified more or less extensively; but from the previous experience of those who have laid down the route to be taken it will probably be carried out pretty much as is intended, though some of the country to be traversed is absolutely unexplored, and much of it very imperfectly known. Wherever a prospect of doing work is found, a longer or shorter halt will be made, and as the Expedition is to be well furnished with camels—no fewer than twenty-three being taken with it—the difficulties that attend the needful supply of water will be reduced to a minimum, while it is said that owing to recent good rains in the latitudes to be passed through everything looks promising for a successful journey.

The importance of this undertaking is not easily to be over-rated. Expeditions of one kind or another to the interior of the continent have been numerous, and

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productive of results that we should be the last to impugn; but this we believe is the first attempt at a purely scientific investigation of Central Australia, while the names of the distinguished men whom Mr. Horn has been so fortunate as to engage in it, are a guarantee of the serious way in which it will be conducted. We doubt not that he and his companions will find plenty of rough work before them, and possibly some risk; but if good wishes can help them they may rely on those of all our readers, together with their high and hearty appreciation of the spirit which has prompted that gentleman not only to defray the cost of the Expedition, but to put himself at the head of it at a time of life when most men think of retiring upon the fruits of their labours.

THE ENRICHMENT OF COAL-GAS.

It is almost impossible to over-estimate the importance of the influence which coal-gas has exercised upon the advancement of civilisation during the past fifty years, and at the present time it has reached a phase in its existence upon which its future career and utility is very largely dependent.

Up to the middle of the century but little attention was paid to the quality of the gas supplied for illuminating purposes; the gas manager made the best gas he could with the coals at his disposal, and the consumer was content as long as he obtained a reasonable amount of light.

In 1850 a Bill was passed which enacted that the light emitted by a brass argand burner with 15 holes, consuming five cubic feet of gas per hour, should be equal to the light of 12 wax candles of the size known as "sixes." These wax candles were, however, only equal in illuminating power to 10·3 of the sperm candles at present used for testing purposes. In 1860 an Act changed the illuminating power to 12 sperm candles, and in 1868 this was again raised to 14 candles, and by the Act of 1876 this was increased to 16 candles, and remains so to the present time.

In 1864 the 15-hole brass argand was discarded as a standard testing burner, and was replaced by a 15-hole steatite burner, which by increasing the temperature of the flame developed more light, whilst in 1869 the "London argand" 24-hole burner was introduced, and gave a still further increase in the light obtained from the gas, so that when we speak of London being supplied with 16 candle-power coal-gas, it means that the light emitted by the gas when burning at the rate of 5 cubic feet per hour from a London argand shall be equal to the light of 16 sperm candles of the size known as sixes consuming 120 grains of sperm each per hour.

When we come to consider what this in reality amounts to, we find that by one of those subtle strokes of humour in which our legislative body occasionally indulges, it means to the consumer almost anything except a light equal to 16 candles. The illumination which can be obtained by the consumption of coal-gas is entirely dependent upon the method by which the gas is burned. From a so-called 16-candle coal-gas the consumer rarely obtains a value of more than 12 candles per 5 cubic feet of gas consumed; whilst by using burners of rational construction, upwards of 40-candle illuminating power could be obtained for the same consumption of gas.

The light emitted by a coal-gas flame is dependent upon its temperature, and flat-flame burners, exposing a thin sheet of flame to the cooling action of the air, give the worst results. Argand burners are better, as the cooling is not so great, whilst the regenerative burners lately introduced, by utilising the heat of the products of combustion for raising the temperature of the gas and air supplied to the flame, give an enormous increase in the light emitted.

If the gas companies could only get an Act passed authorising the use of the regenerative burner as the standard, there is no reason why they should not call the gas at present supplied 40-candle gas; the consumer, however, using the flat-flame burner would still be only obtaining the same light as at present. Incandescent mantle burners, which act on a totally different principle, also yield a high illuminating value.

On carefully testing the burners in ordinary use we find that for an equal consumption of gas the results at once show the enormous advantage to be obtained by regeneration, and also how serious is the loss which attends the employment of ordinary burners.

Light obtained per cubic foot of 16-candle gas consumed.

Burner.	Candle units.
Regenerative and incandescent	7 to 10·00
Standard argand	3·20
Ordinary ,, ...	2·90
Flat-flame No. 7	2·44
,, ,, 6	2·15
,, ,, 5	1·87
,, ,, 4	1·74
,, ,, 3	1·63
,, ,, 2	1·22
,, ,, 1	0·85
,, ,, 0	0·59

These burners were by well-known makers; but there are plenty of cheap German nipples in the market which will give even worse results. In the above table No. 7 is the largest flat-flame burner given, as any larger size would never be used for indoor illumination; but with some of the big flat-flame burners employed for outdoor work as much as three candle power per cubic foot of gas is developed by the best make, while it is also quite possible to find cheap imitations of them, which can scarcely be distinguished by their appearance, only developing a little more than one candle per cubic foot. It seems probable that 10-candle units represent the maximum light to be obtained in practice per cubic foot from the so-called 16-candle coal-gas, as, although greater regeneration will increase it as high as sixteen units, the heat is so intense that the burner is quickly destroyed. Taking 10-candle units as being the maximum amount of light for a consumption of one cubic foot of gas per hour, an approximate idea of the waste of illumination which attends the ordinary methods of burning the gas can be formed.

If the burners most commonly in use in houses be examined they will be found to consist chiefly of No. 4 and No. 5 flat-flame nipples, and it would not be over-estimating the number in use to put them at 85 per cent. of the total. The remaining 15 per cent. is made up of larger flat-flame burners, argands, and regenerative lamps, which give a higher service; but it will be found that the total value obtained will not exceed 2·5 candles per cubic foot. This means that 75 per cent. of the total value obtainable from the gas is wasted, and that for our present expenditure in coal-gas we could obtain four times as much light.

Mr. George Livesey some time ago proposed that unenriched coal-gas should be supplied to the consumer at a lower rate than is at present charged for the enriched 16-candle gas, and this question is of such interest and importance to both consumer and gas company that it deserves the gravest consideration.

In large towns like London, where the gas companies have to supply a gas of specific illuminating power, and where the gas is continually subjected to photometric tests at stations spread over the whole area supplied (any deficiency in the lighting value of the gas being visited with rigorously enforced penalties), enrichment in some form or other becomes a practical necessity. In London the gas has to have an illuminating power of sixteen

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